

**METHOD AND APPARATUS FOR DESORBING METHANE FROM COAL FORMATIONS VIA PRESSURE WAVES OR ACOUSTIC VIBRATIONS**

**BACKGROUND AND SUMMARY OF THE INVENTION**

[0001] This application claims priority based on U.S. provisional application No. 60/410,798 filed September 16, 2002, the specification of which is incorporated by reference herein.

[0002] Coal bed methane is methane that is found in coal seams. Methane is a significant by-product of coalification, the process by which organic matter becomes coal. Such methane may remain in the coal seam or it may move out of the coal seam. If it remains in the coal seam, the methane is typically immobilized on the coalface or in the coal pores and cleat system. Often the coal seams are at or near underground water or aquifers, and coal bed methane production is reliant on manipulation of underground water tables and levels. The underground water often saturates the coal seam where methane is found, and the underground water is often saturated with methane. The methane may be found in aquifers in and around coal seams, whether as a free gas or in the water, adsorbed to the coal or embedded in the coal itself.

[0003] Methane is a primary constituent of natural gas. Recovery of coal bed methane can be an economic method for production of natural gas. Such recovery is now pursued in geologic basins around the world. However, every coal seam that produces coal bed methane has a unique set of reservoir

characteristics that determine its economic and technical viability. And those characteristics typically exhibit considerable stratigraphic and lateral variability.

**[0004]** In coal seams, methane is predominantly stored as an immobile, molecularly adsorbed phase within micropores of the bulk coal material. The amount of methane stored in the coal is typically termed the gas content.

**[0005]** Methods of coal bed methane recovery vary from basin to basin and operator to operator. However, a typical recovery strategy is a well is drilled to the coal seam, usually a few hundred to several thousand feet below the surface; casing is set to the seam and cemented in place in order to isolate the water of the coal from that of surrounding strata; the coal is drilled and cleaned; a water pump and gas separation device is installed; and water is removed from the coal seam at a rate appropriate to reduce formation pressure, induce desorption of methane from the coal, and enable production of methane from the well.

**[0006]** When the water is removed from the coal seam, the operator must dispose of it in some manner. Currently, operators dispose of produced water through various water management techniques including re-injection, evaporation, surface discharge, and transportation to an accepted disposal site. These management techniques are expensive, time-consuming and

heavily regulated. Operators would substantially benefit from methods that reduce or eliminate water production from coalbed methane wells.

**[0007]** This invention relates to a method of using devices that induce local pressure drops across a wide distribution of media to induce methane and other gases to desorb from coal without reducing overall formation pressure and a device to carry out the method. An unexpected benefit of this method is that when the gas desorbs from the coal, its natural tendency to increase in volume will cause it to move toward an area of lower pressure. In the desired case, that area would be the wellbore, where the gas would be trapped and collected.

**[0008]** One embodiment of this method involves using an acoustic device (including devices that emit acoustic waves at subsonic, sonic, and ultrasonic frequencies) that induces pressure changes at high frequencies. Those pressure changes could be induced across a large area from a single device location. Thus, one acoustic device located in one wellbore can desorb gas from a large volume of coal.

**[0009]** A further embodiment of this method involves locating the acoustic device in the wellbore at a depth or series of depths in order to maximize gas flow from the formation.

**[0010]** Another embodiment of this method involves using two or more acoustic devices in adjacent wellbores selected in order to maximize gas flow from the formation.

**[0011]** Another embodiment of this method involves using two or more acoustic devices in different formations intersected by the same wellbore in order to maximize gas flow from the formations and the wellbore.

**[0012]** Another embodiment would be to cause the acoustic device to vary the frequency of the acoustic waves in order to affect the penetration of the acoustic waves into the formation.

**[0013]** One embodiment would be to use the acoustic device in an uncased section of the wellbore. Another embodiment would be to use the acoustic device in a cased section of the wellbore. Another embodiment contact between the acoustic device and the casing, formation, or wellbore fluid is controlled so as to achieve a desired result, such as penetration of acoustic waves into the formation.

**[0014]** Another embodiment would be to attach the acoustic device to the casing or other hard material in order to propagate the acoustic waves more broadly throughout one or more formations.

**[0015]** Another embodiment would be to match the acoustical impedance between the device, the wellbore, and the formation in order to maximize or otherwise control penetration of acoustic waves into the formation.

**[0016]** Another embodiment would be to use the acoustic device in a wellbore that intersects a series of wellbores, e.g. through directional drilling techniques, in order to maximize efficient delivery of the acoustic waves to the entire formation.

**[0017]** Another embodiment would be to use the acoustic device in tandem with a technique, such as pumping out formation water, which reduces overall formation pressure.

**[0018]** Another embodiment would be to use the acoustic device in tandem with a technique, such as recirculating water within the wellbore or within the formation, which would serve to make the gas available for capture or separation at the wellbore.

**[0019]** Another embodiment would be to cause the acoustic device to vary the frequency of the acoustic waves in order to affect how gas desorbs from the coal.

**[0020]** Another embodiment would be to use an acoustic device that emits acoustic waves at frequencies between 1 Hz and 200 kHz.

**[0021]** Another embodiment would be to control the solid angle across which the acoustic waves are transmitted into the formation in order to increase energy or to increase interaction with the formation. For example, widening the solid angle would cause the acoustic waves to intersect more of the formation and thus potentially cause greater desorption of methane, although the intensity of the energy would decrease per unit volume. Alternately, narrowing the solid angle would increase the energy per unit volume, but would decrease the amount of formation that is affected by the device. Finding the appropriate level of focus is envisioned in certain embodiments of the invention, where that level of focus is determined by reservoir conditions, device performance, and desired gas production rates.

**[0022]** An aspect of certain preferred embodiments of the invention is the ability of a person that employs it to vary the energy per unit volume of formation of the acoustic waves via electronic, mechanical, chemical, or other means in order to control the rate at which gas desorbs from the coal. With this control, a user of the method and devices can potentially produce gas at rates that are economic without producing it so fast that the formation is damaged or that water is produced or produced at undesirable rates.

**[0023]** For example, a wellbore is drilled to a coal formation. Casing may or may not be installed, cemented and drilled. An acoustic device is lowered into the wellbore until it is at the formation depth. The acoustic device is

actuated. Gas desorbs from the surrounding coal and moves toward the wellbore. The gas is then collected in the wellbore in the usual manner.

**[0024]** Possible sonic devices include devices which produce a mechanical vibration either in the coal or surrounding formations, the water located in the wellbore, the casing or other medium which is placed into the wellbore, or the air located either inside the wellbore or adjacent thereto which propagates the vibration eventually into the coal formation. Such a device includes a horn operable in water and/or air, a vibrator attachable to the casing and/or coal and/or surrounding formation, or other sonic device which operates to produce a mechanical vibration in one or several of the above media.

**[0025]** Another embodiment is to send pressure waves from the surface into the coal formation in order to induce the methane to desorb from the coal. Possible vibration inducing devices include explosives, seismic devices and the like.

**[0026]** Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

[0027] Figure 1 shows a schematic of a wellbore for a coal bed methane formation with an acoustic or sonic device lowered to the coal strata;

[0028] Figure 2 shows a schematic of a wellbore with the acoustic or sonic device transmitting from the surface;

[0029] Figure 3 shows a schematic with the acoustic or sonic device attached to the casing of the wellbore at or near the coal strata;

[0030] Figure 4 shows a schematic of a coal bed methane field with at least two sonic devices lowered into separate wellbores; and

[0031] Figure 5 shows two sonic or acoustic devices in tandem down a wellbore.

## **DETAILED DESCRIPTION OF THE DRAWINGS**

[0032] In a preferred embodiment the acoustic generator is lowered into a wellbore as in Figure 1. The acoustic generator is lowered past the water table of the wellbore to approximately the location of the coal strata. A casing may be inserted into the wellbore in order to provide support necessary in a wellbore.

[0033] The acoustic generator may be connected by way of electric or pressure lines to a suitable device located at the surface. The device located



at the surface may be an electrical generator or an air compressor. The acoustic generator produces mechanical vibrations which emanate into the coal strata to desorb the methane from the coal. The methane then expands in volume and migrates into the wellbore and eventually out of the wellbore.

**[0034]** In another embodiment as shown in Figure 2, the acoustic or sonic generator may be placed at the surface. This surface acoustic generator may supply seismic or other type of pressure waves which travel through ground formation and impact or react with the coal strata thereby producing or desorbing methane from the coal.

**[0035]** Figure 3 shows an acoustic or sonic generator which is attached to the casing in the wellbore. When attached to the casing or wellbore, the acoustic or sonic generator may simply be a vibrator which transfers mechanical force or motion to the casing. The casing in turn would then produce a sonic or acoustic wave which travels into the coal strata to desorb the methane from the coal.

**[0036]** Desirable interference of acoustic or sonic pressure waves may be induced as in Figure 4. Two sonic or acoustic generators may be lowered into wellbores at different locations in a coal field. The sonic or acoustic generators then supply a pressure wave into the coal strata which may interact with an opposing pressure wave from another acoustic or sonic generator in another wellbore. This interference may be beneficial in that

the interference changes the frequency or character of the initial wave and thereby is more directly targeted at a zone in the coal strata for production or desorption of methane.

**[0037]** Figure 5 shows two sonic or acoustic generators in tandem down a wellbore. The tandem sonic or acoustic generators may be positioned at different coal strata in the wellbore or at different locations from a single coal strata to thereby manipulate the impact of the pressure waves onto the coal strata and thereby increase or control the absorption of the methane.

**[0038]** The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.